Category: Materials, Coatings & Processes

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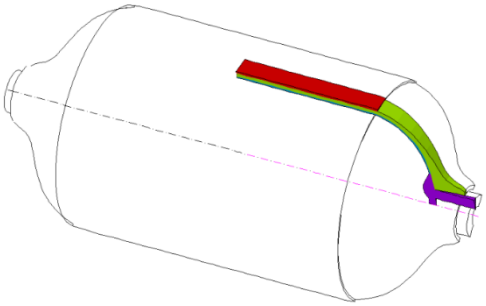
Optimisation of Pressure Tanks Made of Fibre Composites

Fibre composite pressure tanks are increasingly used in space flight due to their high capacity for pressure retaining and their lightweight design.

With this technology separate pressure tanks or also complete engines consisting of a combination of pressure tank and diffusor are designed with very advantageous efficiency weight. However, these requirements which reach the limits of materials and product engineering cannot be met reliably with conventional calculation methods.

Therefore, a new, very detailed calculation model has been developed which is based on the finite element method (FEM) and considers the complete production course, the resulting characteristics and residual stress. E. g., the fibre angles resulting from the winding programme are mapped in the calculation model per layer and position on the tank wall. Moreover, between the generally cylindrical middle part of the tank and the end caps arched in a special shape arise wall thickness variations which are equally detailed calculated in the volume model (see lower Fig.).



Furthermore the calculation model also considers the cooling down after hardening and the Autofrettage, which is necessary in such high-end applications. First examinations between newly designed carbon fibre reinforced (CFC) pressure tanks and the underlying calculation models show a very good conformance. Thus, these methods offer a precise, reliable and in addition effective authoring tool also for different applications.

Innovative Aspects:

The presented, reality exact authoring tool for fibre composite pressure tanks considers in interaction with a winding programme the tank's exact layer composition and its precise local technical features.

The present calculation model allows for the first time to include a metallic liner, which is required for diffusion reasons and which simultaneously serves as winding basis, also concerning the load capacity so that a balanced load ratio between metallic carrier and the fibre wrapping can be adjusted in detail. In addition, the model is also able to consider subsequent production steps so that e. g. by specific overexpanding of the tank ultimately higher securities for cases of working load can be achieve.

Application Areas:

It suggests itself to transfer these high-strength lightweight structures to other application areas. In a concrete research project e. g. CFC pressure tanks are developed for high pressure storage of hydrogen in cars. The aim is to optimise the so far realised tanks, which at maximal 350 bar allow only for a comparably low range of the cars, so that the hydrogen can now be stored at 700 bar.

At the same time bursting pressures of approx. 2,000 bar have to be met. Further possible application areas for the fibre composite pressure tanks are e. g. industrial transport and distribution of pressurized hydrogen, modularly exchangeable stockpiling for stationary plants, lightweight compressed-air systems for rescue tasks or custom-made implementation of pressurizing gas systems in fuel cell vehicles.

Cooperation:

Interest in orders for production development and in cooperation.